Sudden stratospheric warming (SSW) is a meteorological event occurring in the winter polar stratosphere. Space weather phenomena like geomagnetic storms and the SSW are linked to ionospheric variations. How geomagnetic storms modulate an ongoing SSW-induced Equatorial Ionization Anomaly (EIA) signatures is unknown and has remained a major concern. Thus, this research investigated the EIA variabilities of years 2013 and 2014 SSW events and associated geomagnetic storms over the American, African and Asian-Australian sectors.

The EIA signatures during 2013 and 2914 SSW events over the American, African, and Asian-Australian sectors were built from the array of Global Positioning System-Total Electron Content (GPS-TEC) data along the coordinates 75°W, 38°E, and 115°E respectively. The data were retrieved from the archive of the Crustal Dynamics Data Information System (CDDIS). A pair of magnetometer data obtained from the International Real-time Magnetic Observatory Network and National Aeronautics and Space Administration-Thermosphere Ionosphere Mesosphere Energetics and Dynamics (NASA-TIMED) satellite were used to deduce the response of the magnetic field measurement on the ground due to inferred *E X B* drift and showed how the neutral thermospheric O/N 2 composition changed during the SSW occurencies, respectively.

At the 2013 SSW onset, the northern poleward crests over the African and Asian-Australian sectors contradicted the equatorward crest in the American sector. All of the longitudinal sectors in 2013 mid-January, SSW contributed 59% and 63%, to the American and African sector low-latitude ionosphere, respectively compared to 16% and 15% contribution to the American and African sectors, respectively, during the SSW onset. During SSW onset, 84% of SSW contribution was higher than 44% in the mid-January over the Asian-Austrialian sector. In the 2014 major SSW event, the African northern EIA crest moved equatorward compared to the poleward shift seen in the American and Asian-Australian sectors. The TEC magnitude was highest in the American sector (109 TECU), followed by the Asian-Australian (105 TECU), and African (94 TECU) sectors. The longitudinal differences in the northern EIA crest and its TEC enhancement were primarily associated with combined effect of the varying thermospheric wind dynamo, upward directed *E X B* drift and the thermospheric neutral O/N 2 ratio.

Furthermore, a positive response of TEC to the 2014 geomagnetic storms across the longitudinal sectors was observed. This was majorly due to the combined effect of a strong Prompt Penetration of Electric Field (PPEF) and increasing thermospheric O/N 2 ratio. The stronger (ROTI $\geq$ 0.9) and more frequent ionospheric irregularities during the 2014 SSW compared to (ROTI $\geq$ 0.8) the 2013 SSW event may be due to the difference in the solar flux magnitude and thermospheric wind.

In conclusion, it should be emphasized that the development of a well-developed EIA signature during both SSW events with or without the *E X B* drift can be linked to increase in SSW-induced equatorward wind, SSW-induced down-welling O/N 2 effect, and the daytime photo-ionization.